2/pots

MULTI-FILAMENT FOR MOHAIR-LIKE PILE FABRIC AND PILE FABRIC COMPRISING THE SAME AND METHOD FOR MANUFACTURING THE FABRIC

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a multi-filament comprising synthetic fiber used for mohair-like pile fabric and pile fabric comprising this and a method for manufacturing mohair-like pile fabric using synthetic fiber filament.

2. Description of the Related Art

Natural mohair pile fabric obtained from angora goats has the characteristic appearance that the individual hairs constituting the pile are thick and straight in shape and that hairs constituting a single group are partially convergent, or hairs having a large curled shape are partially convergent. Also, although in mohair pile fabric, the individual hairs constituting the pile seem to be thick, it has the characteristic advantages of softness and low stiffness, and excellent heat-retaining properties, enabling it to be used as pile fabric for clothing fur for high quality products and for skins of toy animals such as bears, for example teddy-bears. However, since mohair is a natural product, it is subject to problems such as that the supply

of the raw material is unstable and it is expensive. For this reason, various types of pile fabric using synthetic resin having the characteristics of natural mohair have been studied but no satisfactory product has yet been obtained.

For example, when manufacturing pile fabric by knitting or weaving synthetic fiber, if worsted yarn is employed as the raw material, since the worsted yarn is spun of single fibers to which crimping has been applied, in order to obtain mohair-like fibers wherein the fibers constituting the pile have scarcely any crimp, it is necessary to remove the fiber crimp in a forceful brushing and polishing step after pile formation. However, fine crimp is difficult to remove completely, necessitating forceful brushing in order to remove the crimp right down to the root of the pile and, furthermore, there are problems regarding reproducibility.

Also, if the pile is manufactured by knitting or weaving using directly thick filament, in particular of single fiber thickness about 10 denier (11 dtex) rather than worsted yarn, since there is no intermingling between the single fibers, the problem can easily arise of single fibers dropping out during pile formation. As a means of preventing dropping out of single fibers, industrially, multi-filaments are employed that have been subjected to bulky processing, or pile is formed in which the intermingling property

between single fibers is ensured by means of yarn doubling of multi-filament and worsted yarn; pile of straight shape is then obtained by removing the crimp by polisher processing etc. However, with this method, in some cases fine crimp is difficult to remove or complete removal of the crimp cannot be achieved. A further method is to obtain a pile fabric by a pile forming method using sliver knitting rather than spun yarn or bulky processed filament; however, with this method, since fiber is employed that has been subjected to crimping in order to ensure the intermingling property of the sliver which is used as raw material, after manufacturing the pile fabric, it is necessary to remove the crimp of the fiber constituting the pile. However, in this case also there was the problem, as described above, that it was not possible to fully remove the crimp.

Thus, with the conventional method of manufacturing pile fabric, there were problems such as that there were limits to the straightness of the fiber constituting the pile and that fiber having a good balance of soft feel and nerve of pile could not be obtained.

SUMMARY OF THE INVENTION

An object of the present invention is therefore, using synthetic resin, to provide a novel multi-filament for

obtaining a mohair-like pile fabric wherein the fibers constituting the pile have a good balance of soft feel and nerve of pile and straightness similar to that of natural mohair and a pile fabric comprising this. A further object of the present invention is to provide a method whereby, when forming a mohair-like pile fabric from synthetic fiber, pile fabric similar to that whose raw material is natural mohair can be obtained with little processing loss (loss due to drop-out of single fibers).

As a result of meticulous study, the present inventors discovered that natural mohair-like pile fabric using as raw material synthetic resin could be obtained by employing a multi-filament constituted with fixed conditions. Specifically, the invention was achieved by discovering that a pile fabric presenting an appearance in which the hairs (fibers) constituting the pile have a straight shape and have partially convergent groups characteristic of a pile fabric made of natural mohair could be obtained by forming a pile of pile length for example 5 mm to 100 mm by knitting or weaving multi-filaments made of synthetic fiber that is not twisted or is twisted with a twist frequency of 150 T/m or less.

Specifically, a multi-filament for mohair-like pile fabric according to the present invention is a multi-

filament comprising synthetic fiber and having a single fiber fineness of 3 to 30 denier (3.3 to 33 dtex), and total fineness of 100 to 750 denier (110 to 830 dtex) and twist frequency of 150 T/m or less.

Also, a method of manufacturing a mohair-like pile fabric according to the present invention consists in manufacturing a pile fabric of pile length 5 mm to 100 mm by applying twist of frequency 150 T/m or less to a multi-filament comprising synthetic fiber and subjecting this multi-filament to knitting processing. In the aforesaid knitting processing, preferably the knitting texture is double stitch, but it is also possible to use non-twist filament which has essentially not been subjected to twisting as the multi-filament.

Preferably the multi-filament of the present invention contains at least 50 wt% of fiber of flat cross-section wherein the flat ratio of the fiber cross-section expressed by the ratio of the length L of the long axis of the fiber cross-section and the length W of the short axis (L/W, see Figure 1) (hereinbelow referred to simply as the flat ratio) is 2 to 25.

Also, it is beneficial to coat the multi-filament of the present invention with an oily agent having a convergence-inducing effect.

Furthermore, a multi-filament according to the present invention may be a non-twist filament having essentially non-twist.

Even more preferably, a multi-filament according to the present invention comprises acrylic-based synthetic fibers.

A pile fabric according to the present invention is a mohair-like pile fabric obtained by knitting a multi-filament as mentioned above. Preferably this pile fabric is a mohair-like pile wherein the fibers constituting the pile are essentially not crimped, and the pile length is in the range 5 to 100 mm.

Various types of pile products may be manufactured using the pile fabric of the present invention, but, suitably, the pile fabric of the present invention is employed as an industrial raw material in particular for clothing, toys (skins of toy animals) or interiors.

The present invention is described in further detail below.

"Multi-filament" as used in the present invention means an assemblage of two or more monofilaments having a continuous length and in ordinary synthetic fiber classification is classified as "long fibers".

Preferably multi-filament according to the present invention comprises synthetic fiber whose single fiber

fineness is in the range 3 to 30 denier (3.3 to 33 dtex) and whose total fineness is in the range 100 to 750 denier (110 to 830 dtex). If the single fiber fineness is less than 3 denier (3.3 dtex), the feel of the pile is too soft and it tends to have little nerve; also, the appearance of the fiber constituting the pile is thin i.e. it does not appear like the thick hair that is characteristic of mohair, and so is undesirable. On the other hand, if it exceeds 30 denier (33 dtex), the rigidity of the fiber constituting the pile is large, with the result that the feel of the pile is rough i.e. it is too firm, tending to lose the soft touch that is characteristic of mohair, and so is undesirable. Fiber whose single fiber fineness is small, and which is soft and of little nerve is more suitable for products of short pile length; on the other hand, fiber whose single fiber fineness is large and which is hard and has good nerve is more suitable for products of long pile length; even in the above range of 3 to 30 denier (3.3 to 33 dtex), for example in order to obtain a pile of hard feel, the single fiber fineness may be made large and the pile length short. Also, if the total fineness of the multi-filament is less than 100 denier (110 dtex), when the mohair-like pile fabric is manufactured, the finished weight per unit area of the fabric becomes very small, so the under-layer of the pile is

exposed; this gives rise to the problems of lowered value of the product and facilitation of yarn breakage in the knitting step; also, since the knitting has to be dense in order to raise the density of the pile, productivity tends to be lowered. On the other hand, if the total fineness of the multi-filament exceeds 750 denier (830 dtex), the finished weight per unit area of the pile becomes very large, making the weight of the fabric large and making the feel of the pile hard; this is therefore undesirable; in addition, since the multi-filament becomes too thick, problems frequently occur in the knitting step, in that some of the single fibers of the multi-filaments escape the needle, so that sometimes uniform knitting cannot be performed. A preferred range of total fineness of the multi-filament should be selected in accordance with the material of the fibers, but, in particular in the case of acrylic-based fibers, a range of 100 to 750 denier (110 to 830 dtex) is preferable and from the point of view of maximizing "feel", a range of 150 to 600 denier (170 to 670 dtex) is preferred.

There are no particular restrictions regarding the synthetic fiber material of the multi-filaments for the mohair-like pile fabric of the present invention, but use of acrylic fibers, acrylic-based fibers, polyester fibers, or polyamide fibers etc such as are used as the raw filaments

for ordinary pile is preferred; of these, acrylic-based fibers are particularly superior as the material for mohair-like pile fabric since the fibers themselves have an appearance and "feel" like animal hair. Acrylic-based fibers as referred to herein are synthetic fibers whose raw material is a polymer containing at least 30 wt% of acrylonitrile and, apart from acrylonitrile homopolymer, may be a copolymer obtained by copolymerization using a vinyl-based monomer capable of copolymerizing with acrylonitrile. Examples of vinyl-based monomers capable of copolymerizing with acrylonitrile include: vinyl chloride, vinylidene chloride, vinyl bromide, vinylidene bromide, acrylic acid esters, methacrylic acid esters, acrylamide, methacrylamide, or mono- or dialkyl derivatives of these, acrylic acid, methacrylic acid, itaconic acid, styrene sulfonic acid, methacrylic sulfonic acid, methacryloyl oxybenzene sulfonic acid, methacryloyl oxypropylene sulfonic acid, or metal salts of these and ammonium or amine salts, glycidyl acrylate, glycidyl methacrylate, acrylic glycidyl ether, and methacrylic glycidyl ether. Of these, vinyl chloride or vinylidene chloride are preferred, or, if flame retardant properties are required, copolymers with vinyl chloride or vinylidene chloride are preferred.

When obtaining the target fiber by spinning spinning solution containing a polymer as above by a known method such as the dry method or wet method, stabilizers etc that are beneficial in increasing resistance to light etc may be added if required, and suitable quantities of various additives may be added in order to adjust glossiness. Furthermore, in order to obtain colored fibers, suitable amounts of pigments or dyes etc may be employed and, if high flame retardance is required, suitable amounts of flame retardant may be added in a range that does not impair the "feel" of the pile. Furthermore, in order to prevent cracking of the cross-section of the fiber, 1 to 20 wt% of a rubber-like substance such as is disclosed in for example Laid-open Japanese Patent Application No. Sho. 58-215744 may be added to the spinning solution.

Also, as a method of applying twist to the aforesaid filament, an up-twister system using for example an Italian-type yarn twisting machine or a double twister system such as is commonly employed for yarn doubling twisting or combination twisting etc may be employed, but there is no restriction to these. Regarding the twist frequency, lightly twisted yarn of a twist frequency of 150 T/m or less is preferable, with the object of preventing partial separation of the filaments in the pile knitting step and/or preventing

fiber loss after manufacture. If the twist frequency exceeds 150 T/m, fine crimp produced by the twisting is left in the pile even after finishing, which is undesirable from the point of view of "feel" and appearance. Also, in order to further accentuate straightness of the pile, it is preferable to employ non-twist filaments having essentially non-twist. "Having essentially non-twist" is a concept that includes not only a condition in which there is non-twist at all but also a condition in which no artificial twisting is carried out.

While there are no particular restrictions regarding the cross-sectional shape of the fiber of the synthetic fiber used in the present invention, it may be of circular cross-section when the pile fabric is manufactured, or may preferably be of flat cross-section, since this tends to give a hard "feel" when the pile is touched. If for example the multi-filament consists of thick fibers of single fiber fineness 20 denier (22 dtex) or more, if the fiber cross-sectional shape is of low flat ratio, the nerve of the pile is high, so preferably the fiber has a highly flat shape of flat ratio of the fiber cross-section at least 6, but if the flat ratio is raised too much, nerve is not particularly increased but the thickness of the fiber to the naked eye becomes large, so preferably the flat ratio is no more than

25. On the other hand, if the multi-filament consists of fine fibers of single fiber fineness 10 denier (11 dtex) or less, if the fiber cross-sectional shape is of high flat ratio, the nerve of the pile becomes very low, so preferably the flat ratio is a low flat ratio of 5 or less; however, if the flat ratio is lowered too far, contrariwise, the nerve becomes too large, so preferably the flat ratio is in a range of 2 to 5. Overall, preferably the flat ratio of the fibers of the multi-filament is in the range 2 to 25. Also, while it is not necessary that all the fibers in the multi-filament should be of flat cross-section, preferably fibers of flat cross-section having a cross-sectional shape within the aforementioned range of flat ratio are present in a proportion of at least 50 wt%. The flatness ratio of the fiber cross-section can be measured by observation of the fiber cross-section of the multi-filament using for example a scanning electron microscope.

Also, in obtaining fiber of flat cross-section as described above, in the case of the wet spinning method, a spinning nozzle maybe employed having a circular or elliptical hole shape, and fiber of the target flat cross-sectional shape may be obtained by suitably adjusting the conditions in the solidification bath. Also, in the case of

dry spinning, a nozzle having a shape close to the shape of the target fiber cross-section is preferably employed.

The pile length in the present invention means the length from the foundation of the pile fabric to the tip of the pile in the standing pile condition. If this pile length is shorter than 5 mm, it tends to be difficult to make the pile lengths uniform so a product approximating to mohair is not obtained and the commercial value is lowered. Also, on the other hand, if knitting is performed such that the pile length is longer than 100 mm, there are problems regarding lowered knitting efficiency and the fibers constituting the pile tend to become mutually intermingled, likewise tending to lower the commercial value of the product. Also, the pile length is related to the flat ratio and single fiber fineness of the synthetic fibers constituting the pile; if the flat ratio of the synthetic fibers is 5 or less and the single fiber fineness is 10 denier (11 dtex) or less, better straightness is obtained as the pile length is reduced and nerve is also increased; consequently, a range of pile length of 10 to 40 mm is preferable. Contrariwise, in the case of synthetic fiber whose flat ratio is high at 7 or more and of single fiber fineness 20 denier (22 dtex) or more, straightness is better and the fiber has more nerve

when the pile length is increased, so a range of pile length of 50 to 100 mm is preferred.

The target mohair-like pile fabric can be produced by knitting or weaving the multi-filament according to the present invention as described above. The pile fabric obtained can be used for clothing, toys (skins of toy animals etc), interiors, or an industrial raw material etc and is particularly well-suited to the applications of clothing and toys in which the characteristic features of natural mohair are made use of.

In manufacturing the pile fabric by knitting or weaving the multi-filament, a known knitting machine or weaving machine can be employed, but, from the point of view of productivity, cost and ease of processing, knitting processing is preferable. The knitting processing of the pile according to the present invention is performed using ordinary knitting processing or a knitting machine remodeled so as to form long pile; in the case of a weft knitted texture, for example a circular knitting machine may be employed and in the case of a warp knitted texture, a raschel machine or tricot knitting machine or the like known knitting machine may be employed; however, there is no particular restriction to these. And in the case where

double stitch knitting is adopted, a known circular knitting machine may be employed.

Also, although, in the above knitting processing, there is no particular restriction regarding the knitting texture, in particular in the case of circular knitting (weft knitted texture) processing, if, rather than an ordinary knitted texture, a double stitch knitted texture is adopted, fiber loss can be prevented and the amount of loss due to dropping out of single fibers in the brushing or polishing step (hereinbelow called processing loss) can be reduced; this is therefore desirable, since it enables a final product to be obtained that shows little fiber loss and has good commercial quality. The aforesaid double stitch knitting texture means a knitting texture wherein, in contrast to ordinary knitted pile in which the standing pile is folded back in a V shape (as shown diagrammatically in Figure 2), knitting processing is performed in which the standing pile is folded back in W shape (as shown diagrammatically in Figure 3).

In the present invention, the multi-filament supplied for knitting may be supplied directly to the knitting machine but, if, when knitting, nap raising occurs due to separation of the single fibers of the filament, such separation (hereinbelow called "loosening") can be

suppressed by increasing the convergence of the single fibers by adding a small quantity of oily agent to the multi-filament. There are no particular restrictions concerning the oily agent which is used to improve the convergence of the single fibers of the multi-filament and oily agents for filaments which are generally marketed and used to improve convergence may be employed. As oily agents for filaments, for example non-ionic surfactants such as polyoxyethylenes, alkyl ethers, polyethers, or polyoxyethylene-ethylene oxide copolymers, or anionic surfactants such as fatty carboxylic acids or amino-acid type soaps or hydrophobic oily agents such as liquid paraffins may be mentioned by way of example; these oily agents may be used alone or as a combination of a plurality thereof. Of these oily agents, liquid paraffin oily agents are particularly desirable; for example MYB-39S (manufactured by Matsumoto Yushi Seiyaku K.K.) is preferable in that when it is employed, although the amount of oily agent adhering is in the range 0.25% to 2.5% with respect to the filament weight, it has little effect on the product, but suppresses loosening of the filaments during knitting. If the amount of oily agent adhering exceeds 2.5%, this gives a sticky feel to the final product giving rise to problems such as that it easily becomes dirty due to

adhesion of dust; it is therefore desirable to suppress loosening with as small an amount thereof as possible. Regarding the method for depositing oily agent onto the multi-filament, there are no particular restrictions as regards method or process and for example a method in which this is added as primary oil or secondary oil in the multi-filament manufacturing step, or direct addition of oil when rewinding the filament obtained onto a filament bobbin after manufacturing the multi-filament may be employed, so long as the desired amount of oily agent is deposited on the multi-filament prior to knitting. After the convergence of the multi-filament has been improved by adhesion of a convergence-inducing oily agent, preferably its twist frequency should be 80 T/m or less, from the point of view of separability of the pile when in the form of pile fabric.

Furthermore, although usually in the case of natural mohair the hairs constituting the pile are in general straight in shape, in particular in cases where the pile length is long, some natural mohair has waviness with about two peaks per inch and is subjected to processing to induce partial convergence. In order to obtain a pile fabric similar to such natural mohair, pile fabric having the desired standing pile configuration may be obtained by processing using hot brushing or a rotary tumbler dryer

after first obtaining straight pile fabric by the method described above.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagram of fiber cross-section given in explanation of the flat ratio of synthetic fiber;

Figure 2 is a conceptual diagram of knitted texture of ordinary knitted pile;

Figure 3 is a conceptual diagram of knitted texture of double stitch knitted pile.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is further described in detail hereinbelow with reference to embodiments; however, the present invention is not restricted to these embodiments.

(Embodiment 1)

Spinning solution of 29.5 wt% was prepared by dissolving copolymer resin comprising 49.5 wt% of acrylonitrile, 50 weight% of vinyl chloride, and 0.5 wt% of sodium styrene sulfonate in acetone; this spinning solution was colored beforehand using an acetone soluble cationic dye, and wet spinning was then performed at high speed in a 10 weight% aqueous solution of acetone, using a circular nozzle (ø 0.18 mm, number of holes: 50). The gel-like fiber

obtained was subjected to high-speed drawing of 2.5 times in warm water at 50ºC to 60ºC, then, further, in a somewhat relaxed condition, subjected to solvent removal by dwelling in a warm water bath of 60ºC to 65ºC for 20 seconds or more; NewSoft BN (manufactured by Kitahiro Chemical Company Ltd), which is a generally commercially available soft finishing polyethylene/polyamide-based oily agent was then deposited thereon in the amount of 1.0% with respect to the fiber weight and the fiber subjected to drying at a drying temperature of 150ºC, then again subjected to hot drawing of 3.4 times in the same atmosphere, and subjected to relaxation heat treatment of 12% at 160ºC. Next, multi-filament was obtained by depositing 1.4% of liquid paraffin-based mineral oil as secondary oily agent with respect to the weight of the fiber, prior to the winding step. The single fiber fineness of this multi-filament was 10 denier (11 dtex) and the total fineness 500 denier (560 dtex). Also, when the fiber cross-sectional shape of this multi-filament was observed using a scanning electron microscope, it was found that 68 wt% of fibers of flat cross-section were present in this multi-filament, the flat ratio of these fibers of flat cross-section being 3.8 on average. A double yarn base yarn of polyester multi-filament [single fiber fineness 3 denier (3.3 dtex), number of filaments: 50f,

total fineness 150 denier (170 dtex)] and acrylic, of yarn number count 1/30, was used to knit a pile fabric using this multi-filament, using a circular knitting machine [circular knitting machine manufactured by SUNG CHANG Machinery of the Republic of Korea, gauge number: 14 G, course number: 23 course/inch] set to double stitch texture; the back surface of the pile was coated with acrylic acid ester based resin and drying performed for 5 minutes at 130ºC using a pin tenter drier. Pile fabric of pile length 15 mm [finished weight per unit area: 490 g/m^2] was then obtained by aligning the pile directions by processing with a polisher once at 120ºC, then once at 100ºC, followed by shearing surface nap with a shearing machine. When this pile fabric was employed as the skin of a toy animal, it was found to provide mohair-like pile fabric (boa) with a natural subdued glossiness, no stickiness to the touch, and an animal hair-like feel, which was of nerve and excellent bulkiness.

(Embodiment 2)

Spinning solution of 26.5 wt% was prepared by dissolving copolymer resin comprising 93 wt% of acrylonitrile, 6 wt% of vinyl acetate and 1 wt% of methacrylic sulfonic acid in dimethyl acetamide. Wet spinning was conducted at high speed in aqueous solution at 20ºC with 65 wt% of dimethyl acetamide and 35 wt% of water,

using this solution with a flat nozzle (long axis 0.345 mm, short axis 0.115 mm, number of holes 60). After washing the gel-like fiber obtained in warm water, it was subjected to primary drawing of 3.5 times in boiling water. After this, 0.75% with respect to the fiber weight of a mixed oily agent for spinning constituted by 95 weight% of Upol PA-1 (trademark; manufactured by Matsumoto Yushi Seiyaku K.K.), which is a fatty acid ester based oily agent, and 5 wt% of Zontes TL (trademark; manufactured by Matsumoto Yushi Seiyaku K.K.), which is a quaternary ammonium salt based oily agent was deposited onto the fiber, and the filament obtained thoroughly dried, and then subjected to further secondary drawing with a factor of 2 under dry heat and to 10% relaxation heat processing. Furthermore, multi-filament was obtained by depositing 1.0 wt% of liquid paraffin based mineral oil as secondary oily agent prior to the winding step. The single fiber fineness of this multi-filament was 10 denier (11 dtex) and the total fineness 600 denier (670 dtex). Also, when the fiber cross-sectional shape of this multi-filament was observed using a scanning electron microscope, it was found that 92 wt% of fibers of flat cross-section were present in this multi-filament, their flat ratio being 3.0 on average. A double yarn base yarn of polyester multi-filament [single fiber fineness 3 denier

(3.3 dtex), number of filaments: 50f, total fineness 150 denier (170 dtex)] and acrylic, of yarn number count 1/30, was used to knit a pile fabric using this multi-filament, using a circular knitting machine [circular knitting machine manufactured by SUNG CHANG Machinery of the Republic of Korea, gauge number: 14 G, course number: 23 course/inch] set to double stitch texture; the back surface of the pile was coated with acrylic acid ester based resin and drying performed for 5 minutes at 130ºC using a pin tenter drier. Pile fabric of pile length 15 mm [finished weight per unit area: 510 g/m^2] was then obtained by aligning the pile directions by processing with a polisher once at 120ºC, then once at 100ºC, followed by shearing surface nap with a shearing machine. When this pile fabric (boa) was employed as the skin of a toy animal, it was found to provide straight pile fabric of excellent straightness with a natural subdued glossiness, no stickiness to the touch, and an animal hair-like feel, which was of good nerve and excellent bulkiness.

(Embodiment 3)

Spinning solution of 29.5 wt% was prepared by dissolving copolymer resin comprising 49.5 wt% of acrylonitrile, 50 weight% of vinyl chloride, and 0.5 wt% of sodium styrene sulfonate in acetone; this spinning solution

was colored beforehand using an acetone soluble cationic dye, and wet spinning was then performed at high speed in a 10 weight% aqueous solution of acetone, using a circular nozzle (ø 0.15 mm, number of holes: 25). The gel-like fiber obtained was subjected to high-speed drawing of 2.5 times in warm water at 50ºC to 60ºC, then, further, in a somewhat relaxed condition, subjected to solvent removal by dwelling in a warm water bath of 60ºC to 65ºC for 20 seconds or more; a non-convergent oily agent i.e. a soft finishing polyethylene/polyamide-based oily agent (NewSoft BN) just as used in Embodiment 1 was then deposited thereon in the amount of 0.8% with respect to the fiber weight and the fiber subjected to drying at a drying temperature of 150ºC, then again subjected to hot drawing of 3.4 times and subjected to relaxation heat treatment of 12%. Next, multi-filament was obtained by depositing 1.4% of liquid paraffin-based mineral oil as secondary oily agent with respect to the weight of the fiber, prior to the winding step. The single fiber fineness of this multi-filament was 6 denier (6.7 dtex) and the total fineness 150 denier (170 dtex). Also, when the fiber cross-sectional shape of this multi-filament was observed using a scanning electron microscope, it was found that 82 wt% of fibers of flat cross-section were present in this multi-filament, the flat ratio of these

fibers of flat cross-section being 2.3 on average. A double yarn base yarn of polyester multi-filament [single fiber fineness 3 denier (3.3 dtex), number of filaments: 50f, total fineness 150 denier (170 dtex)] and acrylic, of yarn number count 1/30, was used to knit a pile fabric using this multi-filament, using a circular knitting machine [circular knitting machine manufactured by SUNG CHANG Machinery of the Republic of Korea, used under the conditions: course number: 26 course/inch, gauge number: 14 G, slip draft: 30 mm] set to double stitch texture; the back surface of the pile was coated with acrylic acid ester based resin and drying performed for 5 minutes at 130ºC using a pin tenter drier. Pile fabric of pile length 15 mm was then obtained by aligning the pile directions by processing with a polisher once at 120ºC, then once at 100ºC, followed by shearing surface nap with a shearing machine. When the straight pile fabric (boa) obtained by standing pile finishing thereof with a carding polishing finisher was employed as the skin of a toy animal, it was found to provide mohair-like pile fabric with a natural subdued glossiness, presenting a special appearance, no stickiness to the touch, and an animal hair-like feel, which was of good nerve and excellent bulkiness.

(Embodiment 4)

Polyethylene terephthalate of limiting viscosity 0.53 was spun using a melt extrusion machine. For the spinning nozzle, a flat nozzle (long axis width 0.75 mm, short axis width 0.16 mm, number of holes: 30) was employed, spinning being conducted with a spinning temperature of 270 to 285ºC, pulling speed 400 m/min. The multi-filament was obtained by subsequently drawing the fiber obtained with a factor of 2 in hot water at 80ºC, then further drawing by a factor of 2.5 in hot water at 85ºC and performing heat treatment using a heater roll at 140ºC. The single fiber fineness of this multi-filament was 10 denier (11 dtex) and total fineness 300 denier (330 dtex) and, when the cross-sectional shape of this fiber was observed using a scanning electron microscope, the fiber was found to be fiber of flat cross-section of mean flat ratio 4.5. A double yarn base yarn of polyester multi-filament [single fiber fineness 3 denier (3.3 dtex), number of filaments: 50f, total fineness 150 denier (170 dtex)] and acrylic, of yarn number count 1/30, was used to knit a pile fabric using this multi-filament, using a circular knitting machine [knitting machine manufactured by SUNG CHANG Machinery of the Republic of Korea, used under the conditions: course number: 26 course/inch, gauge number: 14 G, slip draft: 30 mm] set to double stitch texture; the back surface of the pile was coated with acrylic acid ester

based resin and drying performed for 5 minutes at 130ºC using a pin tenter drier. Pile fabric of double-stitch texture of pile length 15 mm was then obtained by aligning the pile directions by processing with a polisher once at 120ºC, then once at 100ºC, followed by shearing surface nap with a shearing machine. When the pile fabric (boa) obtained was employed as the skin of a toy animal, it was found to be capable of providing a mohair substitute with a natural subdued glossiness, no stickiness to the touch, and which had good nerve.

(Comparative Example 1)

Spinning solution of 29.5 wt% was prepared by dissolving copolymer resin comprising 49.5 wt% of acrylonitrile, 50 weight% of vinyl chloride, and 0.5 wt% of sodium styrene sulfonate in acetone; this spinning solution was colored beforehand using an acetone soluble cationic dye, and wet spinning was then performed at high speed in a 10 weight% aqueous solution of acetone, using a circular nozzle (ø 0.35 mm, number of holes: 25). The gel-like fiber obtained was subjected to high-speed drawing of 2.5 times in warm water at 50ºC to 60ºC, then, further, in a somewhat relaxed condition, subjected to solvent removal by dwelling in a warm water bath of 60ºC to 65ºC for 20 seconds or more; a soft finishing oily agent just as used in Embodiment 1

(NewSoft BN) was then deposited thereon in the amount of 1.0% with respect to the fiber weight and the fiber subjected to drying at a drying temperature of 150ºC, then again subjected to hot drawing of 3.4 times, and subjected to relaxation heat treatment of 12%. Next, multi-filament was obtained by depositing 1.4% of liquid paraffin-based mineral oil as secondary oily agent with respect to the weight of the fiber, prior to the winding step. The single fiber fineness of this multi-filament was 40 denier (44 dtex) and the total fineness 1000 denier (1110 dtex). Also, when the fiber cross-sectional shape of this multi-filament was observed using a scanning electron microscope, it was found that 68 wt% of fibers of flat cross-section were present in this multi-filament, the flat ratio of these fibers of flat cross-section being 2.8 on average. A double yarn base yarn of polyester multi-filament [single fiber fineness 3 denier (3.3 dtex), number of filaments: 50f, total fineness 150 denier (170 dtex)] and acrylic, of yarn number count 1/30, was used to knit a pile fabric using this multi-filament, using a circular knitting machine [circular knitting machine manufactured by SUNG CHANG Machinery of the Republic of Korea, gauge number: 14 G, course number: 23 course/inch] set to double stitch texture; the back surface of the pile was coated with acrylic acid ester based resin

and drying performed for 5 minutes at 130ºC using a pin tenter drier. Pile fabric of pile length 35 mm [finished weight per unit area: 1050 g/m^2] was then obtained by aligning the pile directions by processing with a polisher once at 120ºC, then once at 100ºC, followed by shearing surface nap with a shearing machine. When this pile fabric was employed as the skin of a toy animal, it was found to be hard to the touch and showed extreme nerve.

The results of the above Embodiments 1 to 4 and Comparative Example 1 are shown in Table 1 below.

Table 1

		Embodiment 1	Embodiment 2	Embodiment 3	Embodiment 4	Comparative Example 1
Single fiber fineness Total fineness		10d 500d	10d 600d	6d 150d	10d 300d	40d 1000d
Twist frequency		Non-twist	Non-twist	Non-twist	Non-twist	Non-twist
Flat ratio (L/W)		3.8	3.0	2.3	4.5	2.8
Fabric evaluation	Straightness	5	5	5	5	5
	Soft feel	5	4	5	2	1
	Glossiness	5	5	5	3	4
	Nerve	5	5	5	4	5
	Overall	5	5	5	3	2

The evaluation methods and evaluation standards in respect of the various evaluation items shown in Table 1 are as follows.

(Straightness)

Evaluation method: based on a functional test (comparison with natural mohair).

Evaluation standard: evaluated in terms of the following five levels:

5: having straightness similar to that of natural mohair.

4: pronounced straightness, but lightly crimped shape partially remaining.

3: overall, a clearly crimped shape remains.

2: overall, a pronounced crimped shape remains.

1: a very pronounced crimped shape remains.

(Soft feel)

Evaluation method: based on a functional test.

Evaluation standard: evaluated in terms of the following five levels:

5: excellent soft feel.

4: good soft feel.

3: no characteristic features.

2: somewhat too soft or somewhat too hard.

1: too soft (no nerve) or too hard.

(Glossiness)

Evaluation method: based on a functional test.

Evaluation standard: evaluated in terms of the following five levels:

5: excellent glossiness feeling like animal hair.

4: glossiness feeling quite like animal hair.

3: no characteristic features.

2: rather glaring glossiness, or rather lacking in glossiness.

1: extremely glaring glossiness, or completely lacking in glossiness.

(Nerve)

Evaluation method: based on a functional test.

Evaluation standard: evaluated in terms of the following five levels:

5: excellent nerve.

4: good nerve.

3: no characteristic features.

2: rather lacking in nerve.

1: completely lacking in nerve.

(Overall evaluation)

Evaluation method: based on a functional test.

Evaluation standard: evaluated in terms of the following five levels:

5: excellent

4: good

3: ordinary (meets standard level)

2: rather poor

1: poor

(Embodiment 5)

Spinning solution of 29.5 wt% was prepared by dissolving copolymer resin comprising 49.5 wt% of acrylonitrile, 50 weight% of vinyl chloride, and 0.5 wt% of sodium styrene sulfonate in acetone; this spinning solution was colored beforehand using an acetone soluble cationic dye, and wet spinning was then performed at high speed in a 10 weight% aqueous solution of acetone, using a circular nozzle (ø 0.15 mm, number of holes: 50). The gel-like fiber obtained was subjected to high-speed drawing of 2.5 times in warm water at 50ºC to 60ºC, then, further, in a somewhat relaxed condition, subjected to solvent removal by dwelling in a warm water bath of 60ºC to 65ºC for 20 seconds or more; a soft finishing oily agent just as used in Embodiment 1 (NewSoft BN) constituting a non-convergent oily agent was then deposited thereon in the amount of 0.7% with respect to the fiber weight and the fiber subjected to drying at a drying temperature of 150ºC, then again subjected to hot

drawing of 3.4 times, and subjected to relaxation heat treatment of 12% and wound on a bobbin as non-twist yarn. The single fiber fineness of this multi-filament was 10 denier (11 dtex) and the total fineness 500 denier (560 dtex). A double yarn base yarn of polyester multi-filament [single fiber fineness 3 denier (3.3 dtex), number of filaments: 50f, total fineness 150 denier (170 dtex)] and acrylic, of yarn number count 1/30, was used to knit a pile fabric of pile length 7 mm using the non-twist yarn multi-filament that was thus obtained, using (a) a circular knitting machine set to ordinary knitting texture and (b) a circular knitting machine set to double-stitch texture [using for both (a) and (b) a circular knitting machine manufactured by SUNG CHANG Machinery of the Republic of Korea, gauge number: 14 G, course number: 23 course/inch]. The back surface of this pile fabric was coated with acrylic acid ester based resin and drying performed for 5 minutes at 130ºC using a pin tenter drier. Pile fabric of pile length 7 mm [finished weight per unit area: (a) ordinary knitting: 400 g/m^2, (b) double-stitch knitting: 450 g/m^2] was then obtained by aligning the pile directions by processing with a polisher once at 120ºC, then once at 100ºC, followed by shearing the pile surface with a shearing machine, after performing a single brushing step. Both of the pile fabrics

(a) and (b) which were thus obtained were pile fabrics in which a straight shape was maintained from the bottom of the foundation in the same way as in the case of fabric directly knitted from the filament and constituted products having a straight type appearance and soft sensation to touch similar to that of pile fabric in which natural mohair was employed as the raw material. Also, whereas, in order to obtain fabric of pile length 7 mm, for pile weight of 100 g, processing loss of 7.0 g occurred in the ordinary knitting of fabric (a) in the polishing step, brushing step and shearing step, in the case of the double stitch knitting of fabric (b), the processing loss was 1.2 g. in the final product Also, in the case of the fabric (a) obtained by ordinary knitting, loss of fibers when the surface was rubbed by hand was experienced, making this product inferior when compared with double stitch fabric (b).

(Embodiment 6)

Spinning solution of 26.5 wt% was prepared by dissolving copolymer resin comprising 93 wt% of acrylonitrile, 6 wt% of vinyl acetate and 1 wt% of methacrylic sulfonic acid in dimethyl acetamide. Wet spinning was conducted at high speed in aqueous solution at 20ºC with 75 wt% of dimethyl acetamide and 25 wt% of water, using this solution with a circular nozzle (diameter ø 0.15

mm, number of holes 100). After washing the gel-like fiber obtained in warm water, it was subjected to primary drawing of 3.5 times in boiling water. After this, 0.65% with respect to the fiber weight of Zontes IB (trademark; manufactured by Matsumoto Yushi Seiyaku K.K.), which is a soft finishing oily agent constituting an oily agent for spinning was deposited onto the fiber, and the filament obtained thoroughly dried, and then subjected to further secondary drawing with a factor of 2 under dry heat and to 10% relaxation heat processing. Furthermore, multi-filament of single fiber fineness 6 denier (6.7 dtex) and total fineness 600 denier (670 dtex) was obtained with (c) no deposition thereof and (d) deposition of 0.5 wt% with respect to the weight of the multi-filament of the liquid paraffin based mineral oil MYB-39S (manufactured by Matsumoto Yushi Seiyaku K.K.) as secondary oily agent prior to the winding step. The non-twist filaments obtained were respectively converted into twisted yarn (hereinbelow called S twisted yarn) by rightwards twisting with a frequency of 60 T/m using an up-twister system employing an Italian type yarn twister. A double yarn base yarn of polyester multi-filament [single fiber fineness 3 denier (3.3 dtex), number of filaments: 50f, total fineness 150 denier (170 dtex)] and acrylic, of yarn number count 1/30, was used to knit a pile

fabric using the S twisted yarn filaments that were respectively obtained, using a circular knitting machine [pile machine: knitting machine manufactured by SUNG CHANG Machinery of the Republic of Korea, gauge number: 14 G, course number: 20 course/inch] set to double stitch texture. The back surface of this pile was coated with acrylic acid ester based resin and drying performed for 5 minutes at 130ºC using a pin tenter drier. Pile fabric of pile length 30 mm [finished weight per unit area: 600 g/m^2 in the case of both (c) and (d)] was then obtained by aligning the pile directions by processing with a polisher once at 120ºC, then once at 100ºC, followed by shearing surface nap with a shearing machine. The pile fabrics (c) and (d) which were obtained were both pile fabrics maintaining a straight shape from the bottom of the foundation just as in the case of pile fabrics manufactured by directly knitting the filament and constituted products having a straight type appearance and soft feel to the touch just like that of pile fabric employing natural mohair as its raw material. Also in the case of fabric (c), a processing loss of 2.0 g occurred, while the processing loss in the case of fabric (d) was 1.1 g. Of the fabrics (c) and (d), fabric (d) was the product offering the best trade-off of commercial quality and processing loss.

(Embodiment 7)

The pile fabric of pile length 30 mm obtained in Embodiment 6(d) was treated for 20 minutes in a rotary tumbler dryer whilst blowing in saturated steam, under a condition of 100% humidity, and internal temperature of 95ºC. After blowing in of saturated steam was discontinued, this was cooled to 60ºC, and the pile fabric taken out. The pile fabric (f) obtained was a product in which the pile bundles had a gentle waviness of about two peaks per inch and a partially converging appearance like that of natural mohair.

(Comparative Example 2)

Staple of 10 denier (11 dtex) x152 mm was obtained by applying eight crimps per inch to acrylic based fiber of the same composition as in Embodiment 6 with a pressing-in type steam setter. It was thereby converted to yarn of yarn number count 2/28, two single yarns twisted 350 (turns/m) are folded and twisted 230 (turns/m). This yarn was used to knit a pile fabric, employing a double yarn base yarn of polyester multi-filament [single fiber fineness 3 denier (3.3 dtex), number of filaments: 50f, total fineness 150 denier (170 dtex)] and acrylic, of yarn number count 1/30, using a circular knitting machine [circular knitting machine manufactured by Nagata Kikai, gauge number: 14 G, course number: 23 course/inch] set to ordinary stitch texture. The

back face of this pile fabric was coated with acrylic acid ester based resin, and drying conducted for 5 minutes at 130ºC using a pin tenter drier. After this, pile yarn twist was untwisted by processing four times using a brushing machine and polishing was performed once in each case at the temperatures 150ºC, 120ºC and 100ºC; the pile surface was sheared using a shearing machine, to obtain a pile fabric of pile length 7 mm, finished weight per unit area 410 g/m^2. Although crimp was removed in a portion of up to about 50% length from the tip of the pile in the direction of its bottom in the case of the pile fabric (g) which was thus obtained, slight crimp was left in the remaining portions so that, compared with the 30 mm pile fabric of Embodiment 6, the appearance of the product presented a different shape to that of straight type pile fabric whose raw material was natural mohair. It was further inferior to Embodiment 6 and 7 in that, in this processing, 15.5 g of pile waste was generated in polishing in order to obtain 100 g of this pile fabric.

(Comparative Example 3)

Spinning solution of 29.5 wt% was prepared by dissolving copolymer resin comprising 49.5 wt% of acrylonitrile, 50 wt% of vinyl chloride and 0.5 wt% of sodium styrene sulfonate in acetone. Wet spinning was

conducted at high speed in 10 wt% acetone aqueous solution using a circular nozzle (ø 0.18 mm, number of holes: 60); the spinning solution was colored beforehand using an acetone soluble cationic dye. The gel-like fiber obtained was subjected to high-speed drawing of 2.5 times in warm water at 50ºC to 60ºC, then, further, in a somewhat relaxed condition, subjected to solvent removal by dwelling in a warm water bath of 60ºC to 65ºC for 20 seconds or more; after this, 1.0% with respect to the fiber weight of Zontes IB (trademark; manufactured by Matsumoto Yushi Seiyaku K.K.), which is a soft finishing oily agent that is generally commercially employed as a spinning or oily agent for converging was deposited onto the fiber, and thorough drying conducted with dry heat of 150ºC and, in addition, hot drawing of 3.4 times under the same atmosphere; 12% relaxation heat processing was then conducted at 160ºC, to obtain the multi-filament. The single fiber fineness of this multi-filament was 10 denier (11 dtex) and the total fineness 600 denier (670 dtex). Also, when the fiber cross-sectional shape of this multi-filament was observed using a scanning electron microscope, it was found that 68 wt% of fibers of flat cross-section were present in this multi-filament, the flat ratio of these fibers of flat cross-section being 3.8 on average. This multi-filament was

converted into S twisted yarn by twisting with a frequency of 350 T/m using an up-twister system employing an Italian type yarn twister. Next, a double yarn base yarn of polyester multi-filament [single fiber fineness 3 denier (3.3 dtex), number of filaments: 50f, total fineness 150 denier (170 dtex)] and acrylic, of yarn number count 1/30, was used to knit a pile fabric using this S twisted yarn filament which was obtained, using a circular knitting machine [pile machine: circular knitting machine manufactured by SUNG CHANG Machinery of the Republic of Korea, gauge number: 14 G, course number: 23 course/inch] set to double stitch texture; the back surface of the pile was coated with acrylic acid ester based resin and dried for 5 minutes at 130ºC using a pin tenter drier. Pile fabric of pile length 35 mm [finished weight per unit area: 1100 g/m^2] was then obtained by aligning the pile directions by processing with a polisher once at 120ºC, then once at 100ºC, followed by shearing surface nap with a shearing machine. When this pile fabric (h) was employed as the skin of a toy animal, it was found to be of inferior straightness, since a crimped shape it was produced by firm twist being left in the standing pile portion. Also, the total amount of pile waste produced in the brushing and shearing steps was to 0.2 g to obtain 100 g of pile.

The results of the above Embodiments 5 to 6 and Comparative Examples 2 to 3 are shown in Table 2.

Table 2

		Embodiment 5	Embodiment 6	Comparative Example 2	Comparative Example 3
Raw material used (twist frequency of twisted yarn)		Multi-filament 10d x 50f (non-twist yarn)	Multi-filament 6d x 100f (60 turns/m)	Worsted yarn 10d x152 mm	Multi-filament 10d x 60f (350 turns/m)
Item for comparison		Knitting texture	Secondary oily agent	Worsted yarn	Twist frequency
Comparison conditions		(a) ordinary knitted texture (b) double stitch texture	(c) 0 (d) 0.5 %	(g) ordinary knitting	(h) 350 turns/m
Pile waste (g/fabric 100 g)		(a) 7.0 (b) 1.2	(c) 2.0 (d) 1.1	15.5	2.2
Evaluation of fabric	Loss of fibers	(a) 3 (b) 5	(c) 4 (d) 5	2	3
	Soft feel	(a) 5 (b) 5	(c) 5 (d) 5	3	3
	Straightness	(a) 5 (b) 5	(c) 5 (d) 5	2	2
	Overall	(a) 4 (b) 5	(c) 4 (d) 5	2	2

The evaluation methods and evaluation standards in respect of the various evaluation items shown in Table 2 are as follows.

(Fiber loss)

Evaluation method: based on a functional test.

Evaluation standard: evaluated in terms of the following five levels:

5: no fiber loss at all when the surface was rubbed by hand.

4: some fiber loss experienced when the surface was rubbed by hand.

3: fiber loss experienced when the surface was rubbed by hand.

2: fiber loss experienced when the surface was rubbed by hand, to an extent such as to cause problems when used as a commercial product.

1: severe fiber loss experienced when the surface was rubbed by hand, such as to cause problems when used as a commercial product.

(Soft feel) and (Straightness)

The evaluation methods and evaluation standards for both of these were the same as in the case of Table 1.

(Overall evaluation)

The evaluation standard was a five-level evaluation in the same way as in the case of Table 1.

By using the multi-filament for mohair-like pile fabric according to the present invention, pile fabric can be obtained which is of excellent straightness, which has a soft feel approximating to that of natural mohair, and yet

which has nerve. By using such pile fabric, pile products can be obtained which are ideal as material for clothing, toys, interiors, or for industrial use. Also, with a method of manufacture according to the present invention, natural mohair-like pile fabric can be obtained using synthetic resin, with little processing loss and which has a soft feel and straight type appearance.